

## Case Study Number 4-1

### Estimating PM<sub>10</sub> and PM<sub>2.5</sub> Emissions from Locomotives

#### *Exercise Objective*

This exercise will test your ability to apply the methodology used to estimate emissions from locomotives.

#### *Directions*

- Review the background information and data provided.
- Convene groups of 4-5 people.
- Answer the questions in the “Problem” section. These will guide you in your thinking to organize the data and then using it to estimate emissions.
- You will have 15 minutes to complete these tasks before the class reconvenes for discussion. Each group will be assigned specific questions and asked to present its results. Other groups will be asked if they agree or disagree with the findings.

#### *Background*

This case study involves the development of a county level locomotive inventory for Sedgwick County, Kansas. In developing this inventory only two SCCs (Line-Haul and Switchyard Operations) are included. The activity data were obtained through a survey of the two railroad companies operating in the inventory area. The purpose of this case study is to require the student to review the activity data that was collected to calculate fuel consumption, and then calculate PM<sub>10</sub> and PM<sub>2.5</sub> emissions for both line-haul and switchyard operations.

#### *Available Data*

The types of data that were obtained from the survey included locomotive fuel consumption rates and traffic density for the large line-haul locomotives; fuel consumption rates and percentage of the total track in the inventory area for smaller line-haul locomotives; and the number of yard locomotives for switchyard locomotives. Because the railroad operated outside the county, the total annual fuel consumption represented locomotives that were operated outside of the inventory area.

The specific data provided by the railroad companies included the gross tonnage by a specific line segment of the rail as well as an estimate of the distance and miles for each of these segments. They also provided a fuel consumption index of 0.00139, which

relates gallons consumed to gross ton-mile. This estimate is assumed to apply for all line segments. This data is presented in the following table.

**Line-haul Locomotive Data Provided by Railroads**

<b>Line Segment</b>	<b>Gross Tonnage, Million GT</b>	<b>Distance in Miles</b>
1	15.0	17.0
2	8.0	15.0
3	0.0	10.5

The smaller of the two railroad companies operating in the inventory area did not have records on the gross tonnage.

The railroad company also provided an estimate of the number of switchyard locomotives that are operating in each switchyard. This particular railroad operates two switchyards and provided an estimate of how often throughout the year each yard was operating. This data is presented in the following table.

**Switchyard Data Provided by Railroads**

<b>Switch Yard</b>	<b>Number of Switchyard Locomotives</b>
1	1.3
2	0.5
Total	1.8

### ***Problem***

As the environmental engineer for the county, you are charged with developing PM<sub>10</sub> and PM<sub>2.5</sub> annual emission estimates for both long haul and switchyard locomotives using the available data. Only emissions are needed for the railroad company that was able to provide data. It is suggested that you approach the problem in the following manner.

1. Are the PM emission estimation methodologies the same for long haul and switchyard locomotives?
2. What PM emission factors are applicable to locomotives?

3. What is the basis of the activity data for locomotives?
4. What is the methodology for estimating  $PM_{10}$  and  $PM_{2.5}$  emissions for line haul locomotives? For switchyard locomotives?
5. What is your estimate of the  $PM_{10}$  and  $PM_{2.5}$  emissions from long-haul locomotives?
6. What is your estimate of the  $PM_{10}$  and  $PM_{2.5}$  emissions from switchyard locomotives?
7. Why does the railroad data on switchyards show fractions of switchyard locomotives in use in each switchyard?
8. Do emissions for each line segment and switchyard need to be calculated individually?
9. How can  $PM_{10}$  and  $PM_{2.5}$  emissions be estimated for locomotives of the smaller company that was not able to provide gross tonnage data?

### *Notes*

- Conversion factors: 453.6 grams = 1 pound  
0.002204 pounds = 1 gram
- Assume that 92% of PM<sub>10</sub> emissions are PM<sub>2.5</sub>.
- EPA uses a default value of 82,500 gallons of fuel consumed for each switchyard locomotive (based on 24 hours a day, 365 days a year).